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Congestion:- Too much traffic in network

How it will found:-

→ If the packet will not reach then the ack was not given then timer out.

→ 3 seenario's

① 2 senders, 2 receivers, buffer infinite and router.

→ sending data at the rate of λ_{in} bytes & B also, Both sharing one router, link capacity R bits each $\left(\frac{R}{2}\right)$

Throughput - No. of packets will send without any delay.

delay - capacity more than $\frac{R}{2}$ then it will be in buffer so cause is cost & packet will not send.

② Here buffer capacity is finite so packet loss then retransmission

original : λ_{in}

↓ plus retransmitted data : λ'_{in}

Throughput

delay - 5 packet, 3 send, 2 lost the $\frac{2}{3}$rd, $\frac{R}{3}$ & $\frac{1}{3}$rd is wasted.

3rd case - No packet will lost but these is a delay b/w queue delay - cause $\frac{1}{4}$th utilized resending - cost

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Unit - 3

Network layer

Main Task - forwarding & Routing

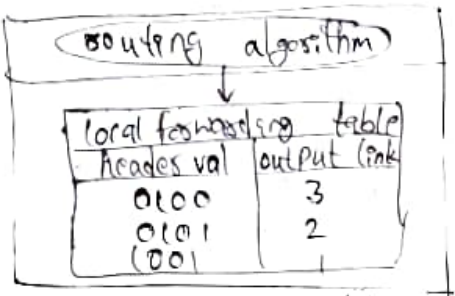
local Action

Receiving the packet from the input link and forward it to the output link

↓

Providing the best path in the network to transfer the packet.

→ Router has built in forwarding table.



→ routing algorithm can be centralized & decentralized & this algorithm can configure the table

→ centralized

→ decentralized - each router has its own

One more function :-

* Connection setup

Connection oriented & Connection less

↓ ↓

Virtual circuits data grams

path Internet is con-less

num

forwarding table

Each link has

Each link has diff vc num, that num was changed or modified by default. the routers has table.

2 reasons:-

1. length will be reduced by changing.
2. state info is mainted in the table

3 phases to

1. VC setup - path b/w src & des
2. data transfer
3. VC terminate

Data Gram:- Con-less

The datagram matches the 21 bits it sends the data packet to it and also sends to the longest matching prefix

22/10/22 Inter Network Layer

→ Routing
→ IP Protocol
→ ICMP

IP Protocol - Main Protocal for Net layer 32 bits, header - 20 bytes if options are increased then header size will be increased.

length - header part & data part (length in bytes 65,535)

datagram capacity 1500 bytes

time-to-live → It will initialized to some value & passes to 1 by 1 router the value is decremented.

(UDP-17, TCP-17)

Upper layer →, datagram has a value that for which layer the protocol has been transferred.

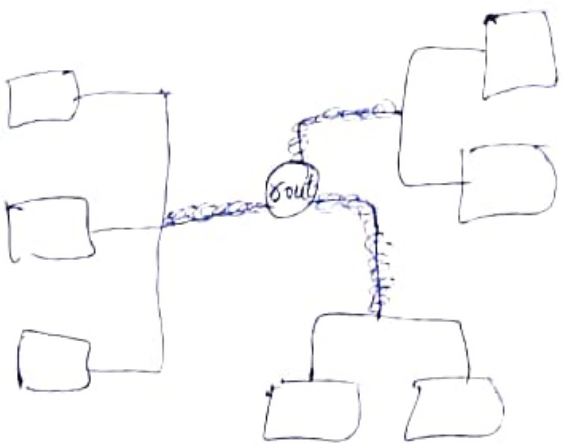
Checksum:- Here checksum is calculated by the router to know the IP header info only.

But in transport layer for whole segment the checksum was calculated.

If all networks follow one link the size is 1500 bytes.
If diff networks follows diff links then the size is large so we can divide the datagram into small parts called fragment & link layer header info will be added to all divided divided parts & 3 phases 16-bit flag, offset number also added for reassembling. Whether the last fragment bit was reached indicates flag
flag - 0 last
1 remaining
Last one packet was reached the offset will be
4000 - 20 bytes header = 3980

IPV4 Addressing

IP address is associated with link interface. 32-bits, 4-octats
These IP address are unique globally.



Subnet The network connecting host and the router is called subnet.
The first 24 bits are common.
Subnet-223.1.1/24 last 8 bit $2^8 = 256$ are connected.
mask

The size of the forwarding table was

CIDR :- Classless Inter Domain Routing
Strategy.
→ first prefix part is subnet part (24)
→ Next suffix part is host part (8 bits)
Ex:- 200.23.16.0/23

Classfull Addressing
class A - 8
class B - 16
class C - 24 (256 - 2 = 254) 0 - 255 (all packets to all hosts) small org.
class D - this address no host

Network administrator contact ISP to has IP subnet, for ISP · ICNN non-profit

After getting the IP address
DHCP - for assigning the IP addresses to the hosts. (temporary / permenant)
client-server protocol
4 step process (If no DHCP then router)
1) DHCP Discover Msg to all hosts
2) DHCP offer
3) DHCP request
4) DHCP ACK.

1/11/22

Default or first-hop router :
The Host which connects the server first is called source router.

Router function :-
Find the least cost path

Graph Abstraction :-
No direct edge is called infinity.

Classification of Routing Algorithms

Global
↓
Gets the complete details like How many nodes, links, cost
prior know
replicate the data to other routers
"link state" algorithm
Dijkstra's

Decentralized
↓
It works in iterative manner - direct attached node info.
"Distance Vector" Algorithm
"Bell

Another Classification :-
Static - Route changes slowly, changes were done by manually.

Dynamic -

link-state algorithm :-

→ Only in iterative manner

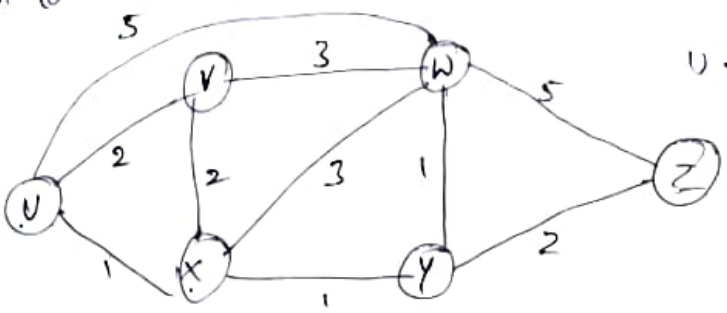
Notations :-

$c(x, y)$, cost from to

$D(v)$, current

$p(v)$, previous

N' - No. of nodes visited already



$U = \{u, x, y, v,$

$D(v) = \min\{D(v), D(x) + c(x, v)\}$

$= \min\{2, 1+2\} = \min\{2, 3\} = 2.$

$D(w) = \min\{D(w), D(x) + D(x, w)\}$

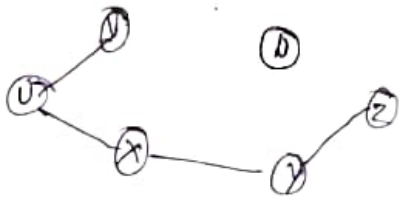
$= \min\{5, 1+3\} = \{5, 4\} = 4.$

$D(y) = \min\{D(y), D(x) + D(x, y)\}$

$= \min\{\infty, 1+1\} = 2$

u router forwarding table

destination	link
v	u, v
x	u, x
y	u, x
w	u, x
z	u, x



7/11/22

Link-layer (provid reliability to wireless networks)

MAC, LLC
↓ ↓
Media Access control — Logical Access Control

framing ↓
no colloid of packets in the network

reliable data services

link layer services (NIC)
flow control
Error Detection } implemented
Error Correction } in hardwar
Sophisticated & effective.
Half & full duplex.

EDC - Error Detection & Correction bits

Techniques - ① parity check

↓ even parity - scheme in 2-D (matrix form)

Odd parity ↓

1 0 1 0 1	1
1 1 1 1 0	0
0 1 1 1 0	1
0 0 1 0 1	

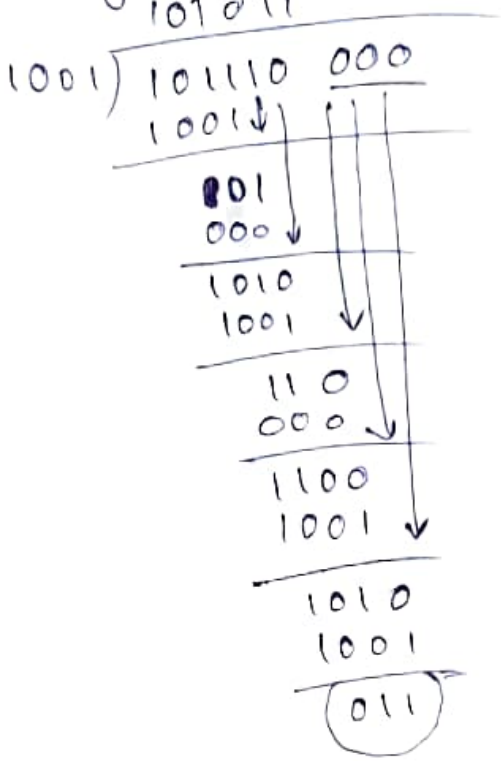
★ CRC :-

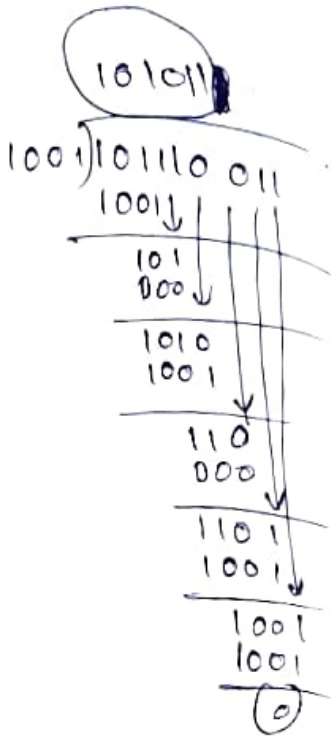
$x^5 + x^3 + x^2 + x + 0$ (: x^4 is not there so '0')
① 0 1 1 1 0

$x^3 + 1$ = ① 0 0 1 → Generator

'G' is agreed by both sender & receiver
G = r + 1 (initially r = 3 (000))
→ left most bit is always ①.

→ If generator has 4 bits & 3-bits





10/11/22 ARP :- Address Resolution Protocal

a host / router has link layer address.

Interface - IP address

adapter / NIC has link

also known as LAN, physical & MAC address.

It occupies 6 bytes - MAC address.

IEEE manages the unique MAC address

Flat structure & Hierarcal structure.

IP address - postal

MAC address - Aadhar

ARP - Translates the IP into MAC address & vice versa.

Each and every host has in-built ARP module so it consist IP & MAC addresses of all the remaining hosts.

The only difference b/w the DNS & ARP are whole network & within the subnet.

If MAC address is not available in table then ARP module with the help of ARP protocal constructs the query & broadcast to all

14/11/22

Elements of wireless network :-

Ex:- phone, laptop which has mobility.

1) Base stations :-

2) Wireless link :- diff. transmission rates.
10-30m 50-200m 200m -

Adhock network works of there as no base station but the host will see it.

3) Infrastructure :-

handoff :- Process of mobile getting into moving from one station and associates with other station.

Types of wireless links :-

Based on 2 criteria.

1. Based on hops (intermediate ,
2. Infrastructure & infrastracture-less

1st classifacation

Single hop infrastructure base

→ 1 base station b/w sender & receiver

Ex:- Bluetooth.

Multi hop infrastructure base

→ more than 1 base station b/w sender & receiver.

Ex:- Wifi

Multi hop — base less

→ Ex:- Vanets.

Wireless link Characteristics:-

→ decreased signal strength :- Path loss

→ interference from other sources:

→ Multipath propagation :- reflect back

Bit error :- Probability of errors occured at receiver.

SNR :- Singnal to Noise Ration

measure of strength b/w received

If hgher the SNR the errors are low

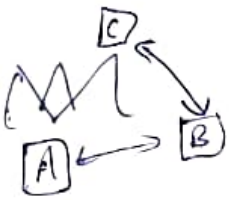
To increase the transmission power through battery.

If hgher SNR then higher BER

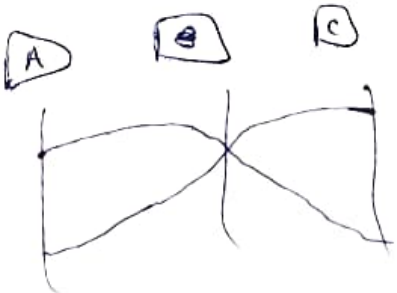
if transmission rate hgh.

Hidden problems:-

Obstacle



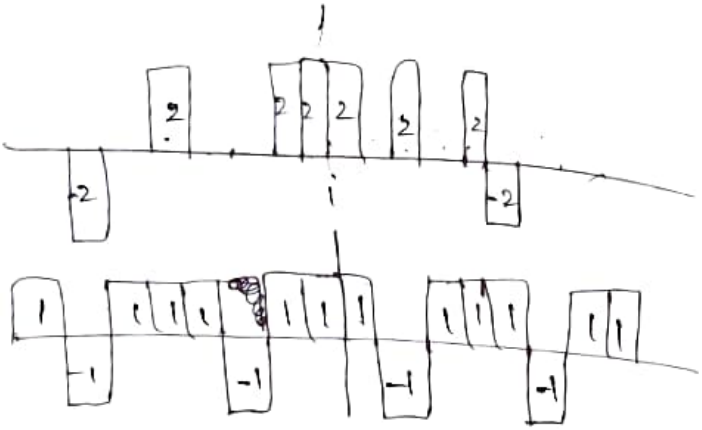
fading



CDMA :- Core Division Multiple Access Protocal. Used on MAC layer when multiple senders send the data there is no interference because of CDMA

Each bit is encoded by multipling with

Each bit sends in 1 unit of time (1 slot).
Each slot is divided int m slots (Ex:- 8)



0+2+0+2+0+0+2+2+2+0+2+0+2+0+0+0+0

$\frac{2+2+2+2}{8} = \frac{8}{8}(1)$ $\frac{2+2}{8} = \frac{4}{8} \frac{1}{2}$

2+0+2

17/11/22 Symmetric encryption Algorithms:-

→ In the symmetric encryption the key is same for encryption & decreption.

DES: symmetric Encryption Algorithm.
Data Encryption standard - 64 bits capacity
56 bits key capacity

3 DES Algorithm:-
112 bits key.

Disadvantage:-
1) Key should be distributed.
During distribution it was hacked.

21/11/22 AES structure

→ It is one of the symmetric algorithm. Proposed by Rijndael

→ plain text msg is 128 bits 16 bytes, (192, 256) bits.

→ plain text was arranged into 4×4 matrix like state array.

128 bits expanded to 44 words each word 32-bits (4 bytes)

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Public key encryption :- Diff

1) 2 keys are used.

2) RSA algorithm based on Diff algorithm.
→ it works with exponentials, integers.
→ 1024(n) and 309 decimals

$C = M^e \bmod n.$

$M = C^d \bmod n$

∵ substitute 'C' value

$M = (M^e \bmod n)^d \bmod n$

$M = M^{ed} \bmod n$

$ed = 1 \bmod \phi(n).$

P.K = E, n

Pri.K = D, n

multiplicative inverses : calculation is based on Euler's theorem

Key generation

Select two prime numbers p, q.

$n = p \times q$

$\phi(n) = (p-1)(q-1)$

public key generation

$e = \gcd(\phi(n), e) = 1$ [prime num less than eulor's Not exact multiple

$d = \frac{k\phi(n)}{e}$

Exam ques:-

1) Define Mobile IP & Explain about Agent Discovery.
2) What is Ethernet & Explain its frame structure.